6.1.2 Cyclogenesis Under Zonal Flow

On 16 and 17 January 1989 zonal flow prevailed over the Bering Sea region. Migratory cyclones approaching from the midlatitudes were steered to the east into the Gulf of Alaska. During periods of zonal flow the cloud patterns over the northern portion of migratory lows, generally the occluded front portion, tend to be sheared off from the lower latitude portions of the front. The lower portions are advected rapidly eastward, and the higher latitude portion of the frontal cloud band becomes aligned east-west and gradually dissipates. As the major cyclogenetic features move rapidly off to the east, small scale cyclogenetic features will form and propagate along the dissipating portion of the "hang-back" front. Figures 6-9 through 6-11 are DMSP images that show a hang-back front and embedded small scale cyclogenetic features under a zonal flow regime. Figure 6-9 shows a frontal band extending southeastward out of the central Bering Sea with frontal shearing indicated by a cross-over cirrus shield near 48 °N, 170 °W. Figure 6-10, from the next orbit, provides

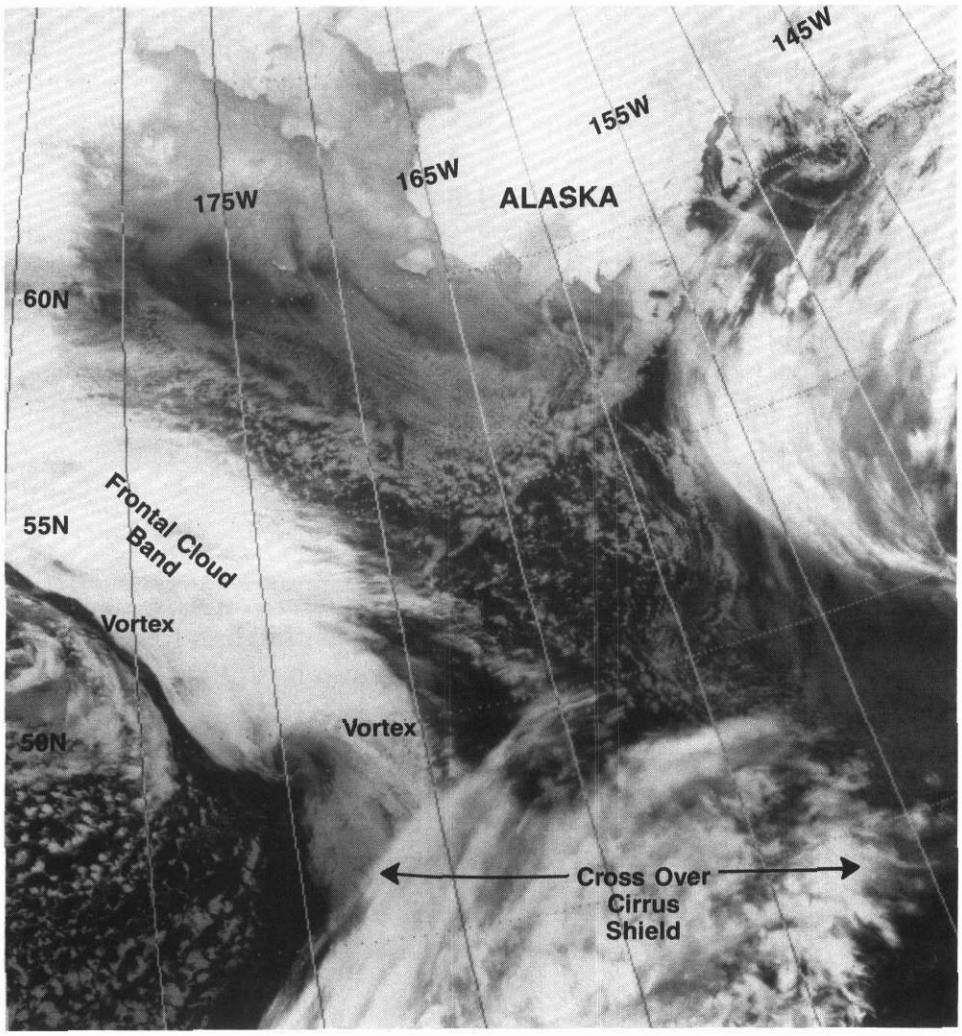

Figure 6-9. DMSP infrared imagery 0512 GMT 16 January 1989.

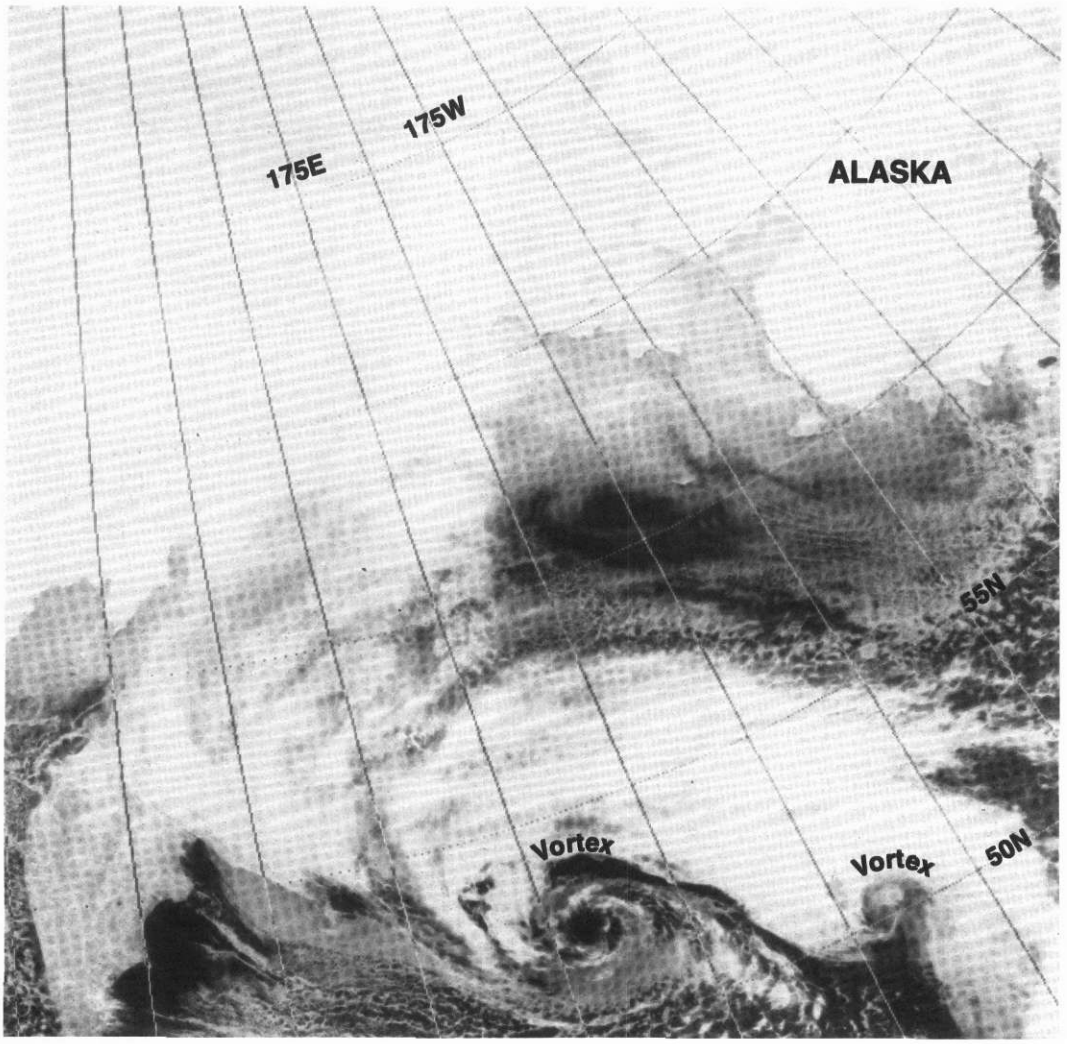

Figure 6-10. DMSP infrared imagery 0654 GMT 16 January 1989.

overlapping coverage and an extended view to the west. Two obvious vortices are seen in the nearly east-west aligned hang-back portion of the frontal band. Figure 6-11, from about 24 hr later, indicates that the lower latitude portion of the frontal system, that part south of the shear area, has moved off to the east. The western part of the hang-back portion of the front has actually moved westward and is influencing the weather over the extreme western Bering Sea and Kamchatka Peninsula. In general, the hang-back portion of the front tends to become nearly stationary and dissipates in place. However, it will continue to cause unsettled weather conditions, which, along with an irregular motion, will create some unique hang-back front forecast problems.

Forecast reasoning, if based on the characteristics of midlatitude behavior of frontal systems, (i.e., generally northeastward movement at 25 to 35 kt, or 45–65 km/hr producing 6 to 12 hr of weather at a given location followed by rapidly improving conditions after frontal passage), must be modified greatly when dealing with hang-back front situations.

Prolonged variable conditions with gradual improvement over a day or two is the rule. The fact that individual cells or cloud features are likely to approach from an easterly quadrant further complicates the forecast problem. It should be noted that the low level flow will generally be easterly in the poleward portions of hang-back fronts and westerly on the midlatitude side.

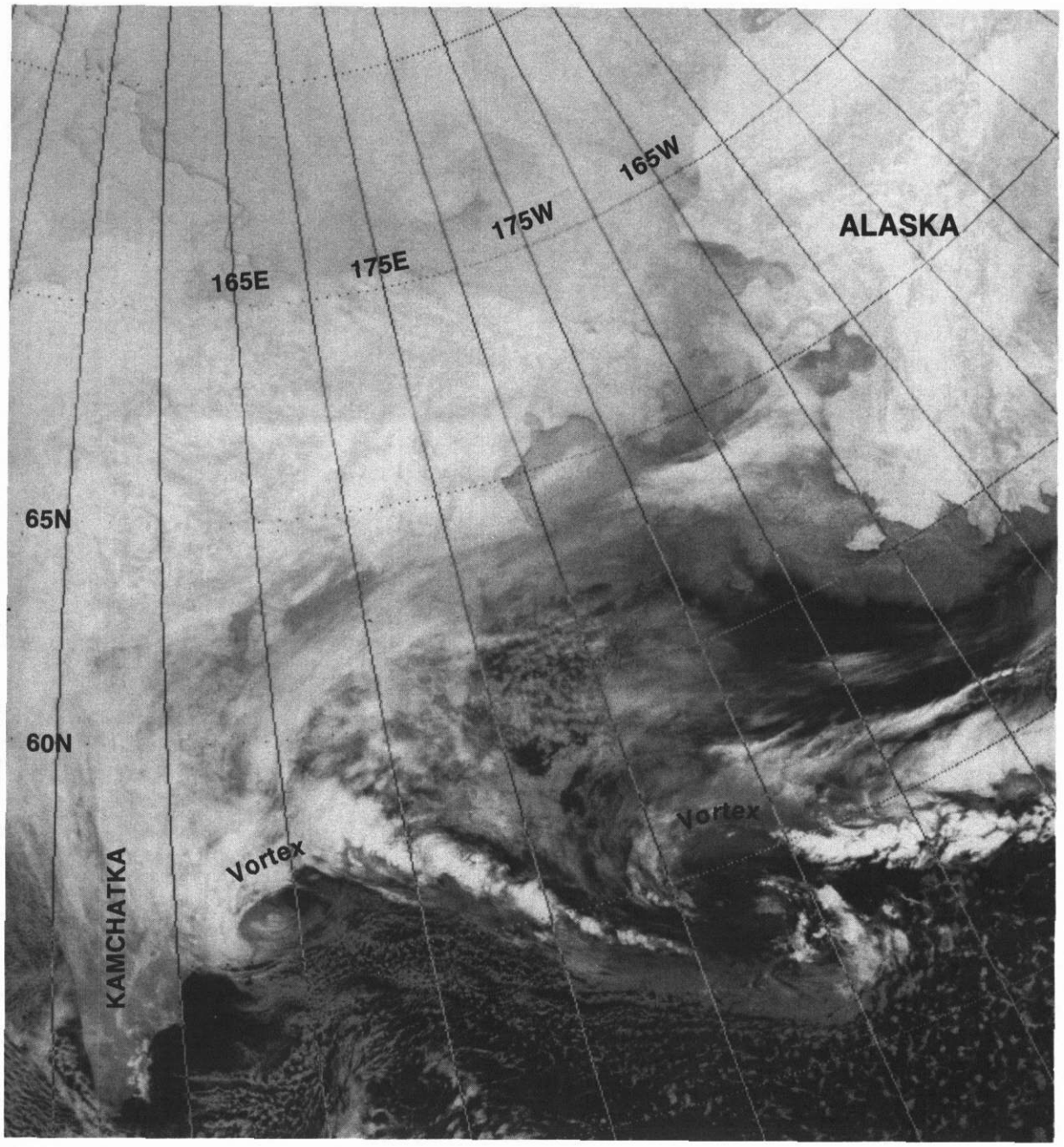

Figure 6-11. DMSP infrared imagery 0641 GMT 17 January 1989.

The 500 mb (Fig. 6-12) and surface (Fig. 6-13) analyses for 1200 GMT 16 January 1989 show the synoptic scale flow during this hang-back front event. South of 50 °N strong zonal flow prevails at the 500-mb level with light winds of variable direction over the Bering Sea. The surface analysis reflects one large west-northwest to east-southeast elongated low, which is nearly vertically stacked under a similarly shaped 500-mb trough. Note that although at least two distinct vortices are evident in the satellite imagery (Figs. 6-9, 6-10, and 6-11)

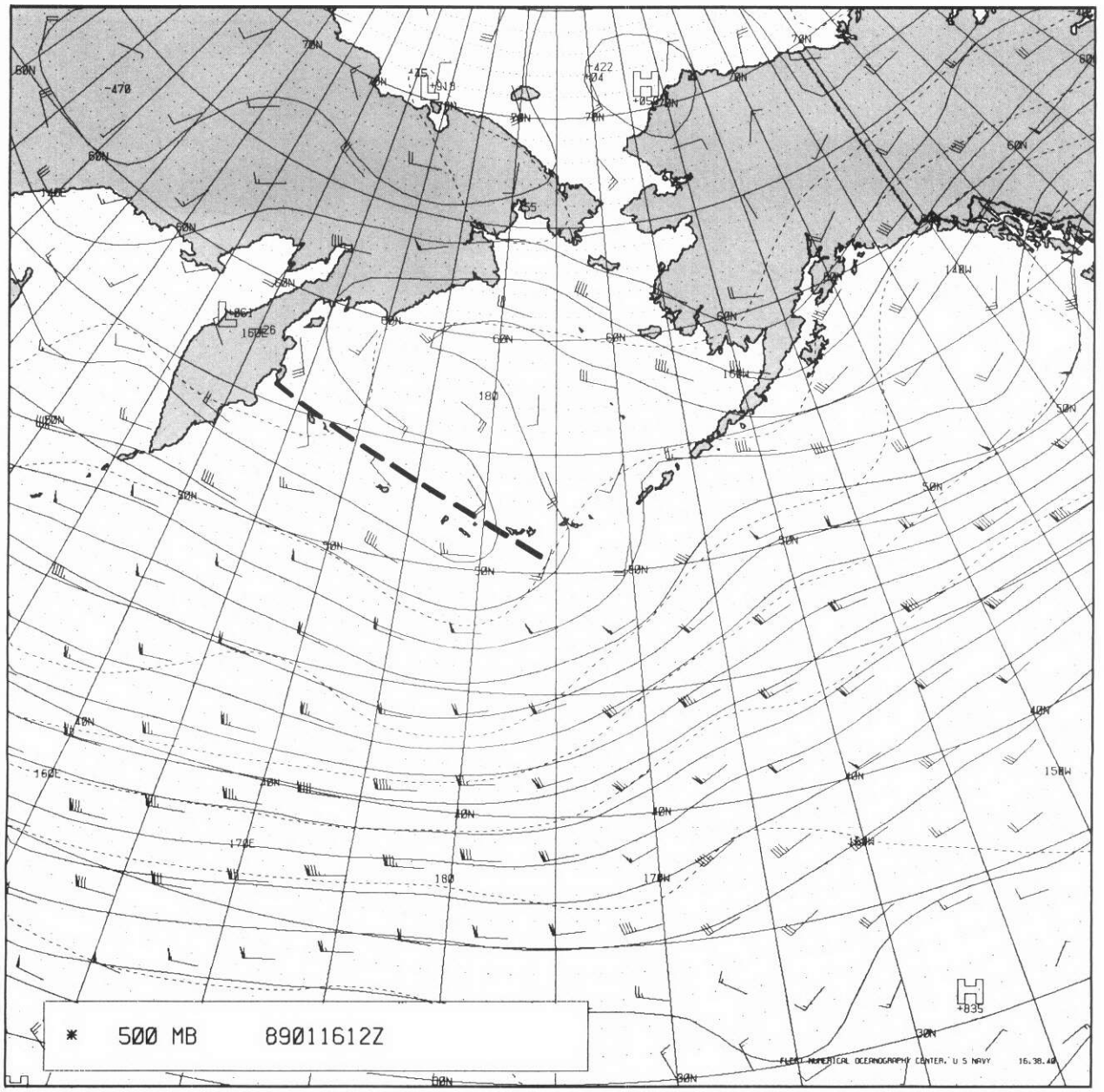

Figure 6-12. FNOC 500-mb analysis 1200 GMT 16 January 1989.

they are not resolved in the surface analysis at 1200 GMT, and not until 0600 GMT 17 January 1989 in following analyses (not shown) is there any indication of multiple vortices along the frontal band. The coarse numerical model resolution, coupled with the probable lack of conventional observation data, is the likely reason for limitations in numerical analysis depiction of these subsynoptic vortices. The numerical analyses do, however, reflect the favorable synoptic scale pattern, and this information, coupled with satellite imagery, will provide the necessary information for accurate short-term (0-24 hr) forecasts.

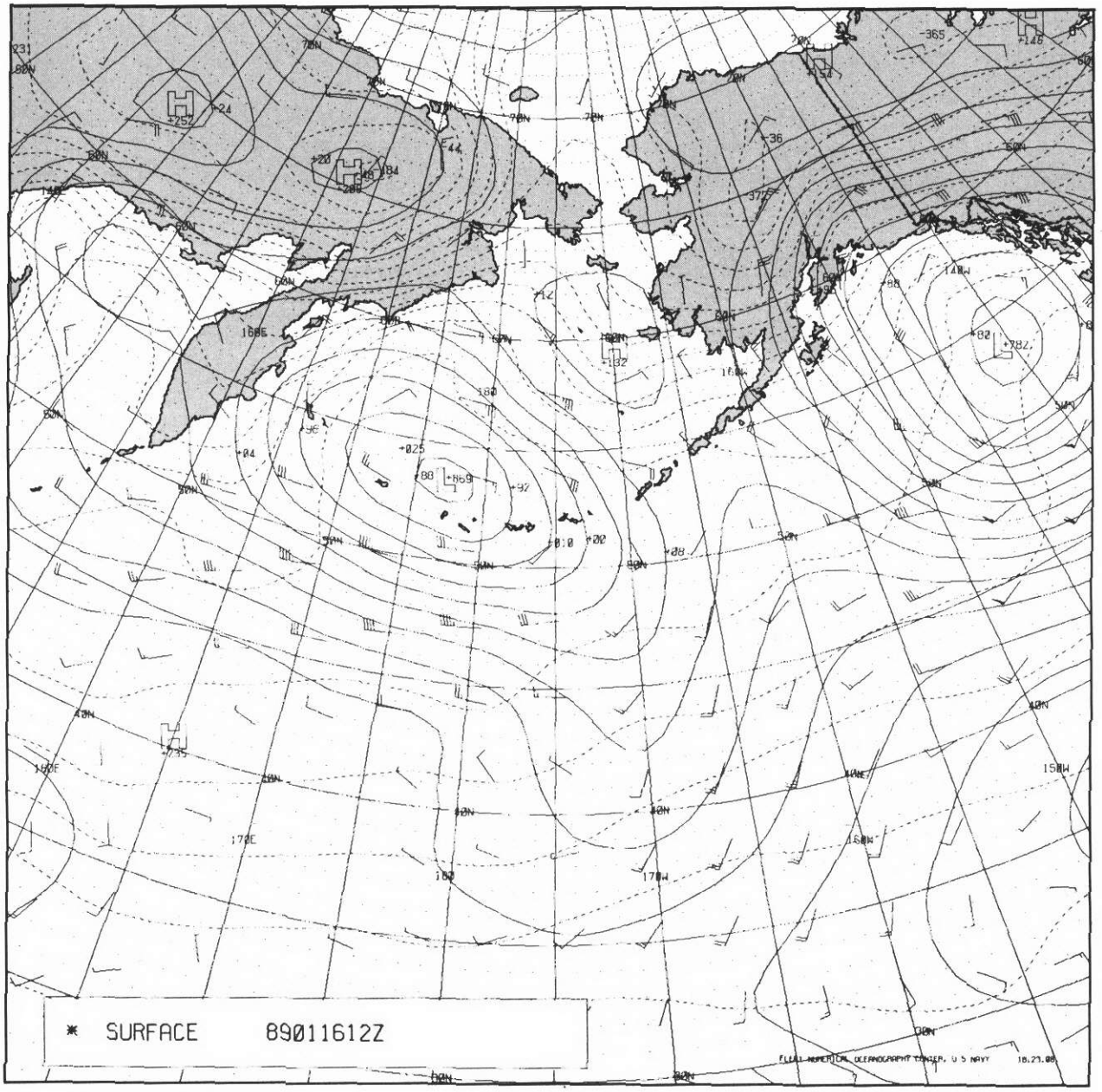

Figure 6-13. FNOC surface analysis 1200 GMT 16 January 1989.

Forecast Aids

1. During periods of strong zonal flow at 500 mb, hang back frontal zones are likely to develop poleward of the zonal flow pattern.
2. The area poleward of the strong 500-mb zonal flow will exhibit light and variable winds aloft.
3. The frontal zone will become elongated nearly east-west and subsynoptic vortices may slowly retrograde westward along with the entire frontal cloud band.
4. This so-called hang back frontal zone will not exhibit the typical behavior of migratory midlatitude frontal systems. It will likely remain nearly stationary for a couple of days with embedded vortices that may also be stationary or move slowly either eastward or westward along the frontal zone.